

CLAIMS

I CLAIM AS MY INVENTION:

1. A resonator for damping pressure waves supported by acoustic energy in a system having a flow path, the resonator comprising:

- 5 a) a first member;
- b) a first plurality of openings through the first member;
- c) a second member maintained in a generally spaced relation to the first member wherein a volume is defined between the first member and the second member and the first member is situated upstream of the second member within the flow path;
- 10 d) a second plurality of openings through the second member, the first plurality and the second plurality of openings being in fluid communication with the flow path so that air passes through the volume;
- e) an upstream portion within each of the second plurality of openings wherein each upstream portion has a first diameter and a first length; and
- 15 f) a downstream portion within each of the second plurality of openings wherein each downstream portion has a second diameter and a second length.

2. The resonator of claim 1 wherein each of the second plurality of openings is comprised of a cylindrical hole through the second member, each hole having a counter-bore forming the upstream portion wherein the first diameter is greater than the second diameter.

3. The resonator of claim 1 further comprising:

25 a) a predetermined thickness for the second member; and
 b) a predetermined lower limit for the second length wherein the first length is formed so that the predetermined lower limit is not exceeded.

4. The resonator of claim 3 wherein the predetermined thickness greater than 0.10 inches.

30 5. The resonator of claim 4 wherein the first diameter is between about 0.150 inches and 0.250 inches.

6. The resonator of claim 5 wherein the first length is grater than 0.040 inches.

7. The resonator of claim 1 further comprising:

a) the first plurality of openings forming a first pattern such that a surface area of the first member between any two of the first plurality of openings is maximized;

5 and

b) the second plurality of openings forming a second pattern such that a surface area of the second member between any two of the second plurality of openings is maximized.

8. The resonator of claim 1 wherein the upstream portion comprises a counter-

10 bore.

9. The resonator of claim 1 wherein the system comprises a gas turbine combustor.

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10. A method of damping pressure waves supported by acoustic energy in a system having a flow path, the method comprising the steps of:

- a) providing a resonator having a first member and a second member defining a volume therebetween;
- 5 b) locating the resonator in the system so that the first member is upstream of the second member within the flow path;
- c) forming a first plurality of openings through the first member;
- d) forming a second plurality of openings through the second member to have a geometry thereby establishing a first acoustic inertance and a first rate of mass flow
- 10 of air through the resonator; and
- e) changing the geometry of the second plurality of openings to reduce the first acoustic inertance to a second acoustic inertance without increasing the mass flow of air through the resonator.

15 11. The method of claim 10 further comprising the step of:

- a) determining a location of the maximum acoustical energy within the flow path of the system; and
- b) locating the resonator proximate the location.

20 12. The method of claim 11 wherein the step of changing the geometry includes the step of counter-boring at least one hole within the second plurality of openings.

13. The method of claim 11 further comprising:

- a) forming each of the second plurality of openings to include a cylindrical upstream portion having a first diameter and a first length; and
- b) forming each of the second plurality of openings to include a cylindrical
- 25 downstream portion having a second diameter and a second length wherein the first diameter is greater than the second diameter.

14. The method of claim 13 further comprising the steps of:
a) selecting a predetermined lower limit for the second length; and
b) forming the first length so that the second length is not less than the predetermined lower limit.

5 15. The method of claim 11 further comprising:
a) forming each of the second plurality of openings to have a cylindrical downstream portion; and
b) counter-boring each of the second plurality of openings.

10 16. The method of claim 11 further comprising the steps of:
a) determining a size for each of the first plurality of openings;
b) determining a size for each of the second plurality of openings;
c) forming the first plurality of openings in the first member so that a surface area of the first member between any two of the first plurality of openings is maximized; and
15 d) forming the second plurality of openings in the second member so that a surface area of the second member between any two of the second plurality of openings is maximized.

17. A combustor system comprising:
a) a flow path through a combustor along which a gas passes from upstream toward downstream;
b) a resonator having a first member and a second member in generally spaced relation to each other and being in fluid connection with the flow path, the first member and second member defining a volume therebetween;
c) a first plurality of openings in the first member; and
20 d) a second plurality of openings in the second member formed to establish a first acoustic inertance that is less than a second acoustic inertance that would be established if the second plurality of openings was formed of cylindrical holes through the second member.

18. The combustor system of claim 17 further comprising:

a) an upstream portion having a first diameter and a first length within each of the second plurality of openings;

5 b) a downstream portion having a second diameter and a second length within each of the second plurality of openings;

c) the second diameter selected to limit a rate of mass flow of air passing through the resonator; and

10 d) the first diameter selected to be greater than the second diameter to achieve a predetermined acoustic inertance.

19. The combustor system of claim 18 further comprising:

a) a predetermined thickness for the second member;

b) a predetermined lower limit for the second length wherein the upstream portion comprises a counter-bore forming the first length so that the predetermined lower limit is not exceeded.

15 20. The combustor system of claim 19 wherein the combustor system is part of a gas turbine.

21. The combustor system of claim 17 further comprising:

a) an upstream portion having a first diameter and a first length within each 20 of the second plurality of openings;

b) a downstream portion having a second diameter and a second length within each of the second plurality of openings;

c) a predetermined thickness for the second member;

d) a predetermined lower limit for the second length wherein the upstream 25 portion comprises a counter-bore forming the first length wherein the first diameter is greater than the second diameter and the predetermined lower limit is not exceeded.

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22. A method of damping pressure waves supported by acoustic energy in a system having a flow path, the method comprising the steps of:

a) providing a resonator having a first member and a second member

5 defining a volume therebetween;

b) forming a first plurality of openings through the first member;

c) forming a geometry of openings in the second member thereby

establishing a first acoustic inertance that is less than a second acoustic inertance that would be established if the geometry were cylindrical holes formed through the second member;

10 and

d) locating the resonator in the system so that the first member is upstream the second member in the flow path.

23. The method of claim 22 further comprising the steps of:

15 a) determining an upper limit for a rate of mass flow of air permitted to pass through the resonator; and

b) forming the geometry in the second member so that the upper limit is not exceeded.

20 24. The method of claim 22 wherein the step of forming a geometry comprises the steps of:

a) forming a second plurality of openings through the second member; and

25 b) counter-boring an upstream portion of at least one of the second plurality of openings so that the upstream portion has a diameter that is greater than a downstream portion of the at least one of the second plurality of openings.